What is claimed is:

1. A method of measuring X-ray reflectivities of a thin film layer on the surface of a sample comprising the steps of:

generating a probe beam of X-rays;

focusing said probe beam on the surface of said sample such that various X-rays within the focused probe beam create a range of angles of incidence with respect to said surface;

measuring the intensity of various X-rays as a function of position within the probe beam as reflected with the positions of the X-rays within said reflected probe beam corresponding to specific angles of incidence with respect to said surface; and

comparing the measurements of the intensity of the various X-rays within said reflected probe beam to corresponding measurements of an unattenuated probe beam made with the sample removed from the X-ray pathway.

2. A method as recited in claim 1 wherein said corresponding measurements of an unattenuated probe beam are made using an X-ray detector located at least in part below the plane of the sample.

3. A method as recited in claim 1 wherein said corresponding measurements of an unattenuated probe beam are made using an X-ray detector located both above and below the plane of the sample.

4. A method as recited in claims 1, 2, or 3 further wherein said measurements of the intensity of the various X-rays within said reflected probe beam are normalized by dividing by said corresponding measurements of the unattenuated probe beam made with the sample removed from the X-ray pathway.

5. A method as recited in claims 1, 2, or 3 further wherein the correspondence between the reflected probe beam and the unattenuated probe beam is obtained by locating a point of symmetry for the two probe beams within the region of small angles of incidence to the plane of the sample such that X-ray reflection from the sample is nearly total.

6. A method of measuring the characteristics of a thin film layer on the surface of a sample comprising the steps of:

generating a probe beam of X-rays;

focusing said probe beam on the surface of said sample such that various X-rays within the focused probe beam create a range of angles of incidence with respect to said surface;

measuring the intensity of various X-rays as a function of position within the probe beam as reflected with the positions of the X-rays within said reflected probe beam corresponding to specific angles of incidence with respect to said surface;

comparing the measurements of the intensity of the various X-rays within said reflected probe beam to corresponding measurements of an unattenuated probe beam made with the sample removed from the X-ray pathway; and

determining the characteristics of said thin film layer based upon the intensity measurements

7. A method as recited in claim 6 wherein said corresponding measurements of an unattenuated probe beam are made using an X-ray detector located at least in part below the plane of the sample.

8. A method as recited in claim 6 wherein said corresponding measurements of an unattenuated probe beam are made using an X-ray detector located both above and below the plane of the sample.

9. A method as recited in claims 6, 7, or 8 further wherein said measurements of the intensity of the various X-rays within said reflected probe beam are normalized by dividing by said corresponding measurements of the unattenuated probe beam made with the sample removed from the X-ray pathway.

10. A method as recited in claims 6, 7, or 8 further wherein the correspondence between the reflected probe beam and the unattenuated probe beam is obtained by locating a point of symmetry for the two probe beams within the region of small angles of incidence to the plane of the sample such that X-ray reflection from the sample is nearly total.

11. A method of locating the focal location of an X-ray optic for use in an X-ray reflectometry system comprising the steps of:

generating a probe beam of X-rays;

focusing said probe beam using said X-ray optic;

measuring the intensity profile of said probe beam at more than one location along the X-ray path from said X-ray optic; and

determining the position of the focus of said X-ray optic as the point of convergence of the edges of said probe beam by extrapolating from the measurements of said intensity profile of said probe beam.

12. A method as recited in claim 11 wherein said X-ray optic includes a Johansson crystal.

13. A method of validating an X-ray optic for use in an X-ray reflectometry system comprising the steps of:

generating a probe beam of X-rays;

passing said probe beam through a grid mask;

focusing said probe beam using said X-ray optic;

measuring the intensity of said probe beam as a function of position; and

validating said X-ray optic based on the occurrence of the maxima and minima in the measurements of the intensity of said probe beam as a function of position.

14. A method as recited in claim 13 wherein said focusing optic includes a Johansson crystal.

15. A method of aligning the bend axis of an X-ray optic for use in an X-ray reflectometry system with a probe beam of X-rays comprising the steps of:

generating said probe beam of X-rays;

passing said probe beam across an obstruction;

focusing said probe beam using said X-ray optic;

measuring the intensity of the focused probe beam as a function of position; and

aligning the bend axis of said X-ray optic by orienting said X-ray optic so as to minimize the width of the shadow cast by said obstruction.

16. A method as recited in claim 15 wherein said focusing optic includes a Johansson crystal.

17. A method as recited in claim 15 wherein said obstruction is a fine wire.

18. A method as recited in claim 17 further wherein said fine wire is oriented substantially parallel to the initial orientation of said bend axis.

19. A method for measuring the tilt of a sample for use in an X-ray reflectometry system comprising the steps of:

generating a beam of light;

directing said beam of light to the surface of said sample;

reflecting said beam of light from said sample;

measuring the reflected beam of light with a position sensitive detector; and

determining changes in the tilt of said sample based on the measurements made by the position sensitive detector.

20. A method of measuring the characteristics of a thin film layer on the surface of a sample comprising the steps of:

generating a probe beam of X-rays;

focusing said probe beam on the surface of said sample such that various X-rays within the focused probe beam create a range of angles of incidence with respect to said surface;

measuring the intensity of various X-rays as a function of position within the probe beam as reflected with the positions of the X-rays within said reflected probe beam corresponding to specific angles of incidence with respect to said surface; and

separately measuring the tilt of said sample in order to either adjust said tilt or to correct the X-ray measurements to account for said tilt.

21. An X-ray reflectometer for evaluating characteristics of a sample comprising:

an X-ray source for generating a first probe beam of X-rays directed to reflect off of the sample;

a first detector for measuring the intensity of the reflected first probe beam and generating first output signals in response thereto;

a processor for evaluating the sample based on the first output signals;

a light source for generating a second probe directed to reflect off the sample; and

a second detector for monitoring the second probe beam after it reflects of the sample and generating second output signals in response thereto, said second output signals being indicative of the vertical position of the sample wherein said processor utilizes the second output signals to measure the vertical position of the sample.

22. A method as recited in claim 20 wherein said tilt is adjusted based on said tilt measurements.

23. A method as recited in claim 20 wherein said X-ray measurements are corrected based on said tilt measurements.

24. A method of measuring the reflectivities of a thin film layer on the surface of a sample including the steps of generating a probe beam of X-rays; focusing said probe beam on the surface of said sample such that various X-rays within the focused probe beam create a range of angles of incidence with respect to said surface; measuring the intensity of various X-rays as a function of position within the probe beam as reflected with the positions of the X-rays within said reflected probe beam corresponding to specific angles of incidence with respect to said surface; and separately measuring the tilt of said sample in order to either adjust said tilt or to correct the X-ray measurements to account for said tilt, said tilt measuring comprising the steps of:

generating a beam of light;

directing said beam of light to the surface of said sample;

reflecting said beam of light from said sample;

measuring the reflected beam of light with a position sensitive detector; and

determining changes in the tilt of said sample based on the measurements made by the position sensitive detector.

25. A method as recited in claim 19 or 24 wherein said step of generating a beam of light includes using a laser light source.

26. A method as recited in claim 19 or 24 wherein said position sensitive detector is a photodiode detector.

27. A method as recited in claim 19 or 24 wherein said tilt is adjusted based on said tilt measurements.

28. A method as recited in claim 19 or 24 wherein said X-ray measurements are corrected based on said tilt measurements.

29. A method for measuring the tilt of a sample for use in an X-ray reflectometry system comprising the steps of:

generating a beam of light;

focusing said beam of light on the surface of said sample;

measuring the reflected beam of light with a position sensitive detector; and

determining changes in the tilt of said sample based on the measurements made by the position sensitive detector.

30. A method of measuring the characteristics of a thin film layer on the surface of a sample including the steps of generating a probe beam of X-rays; focusing said probe beam on the surface of said sample such that various X-rays within the focused probe beam create a range of angles of incidence with respect to said surface; measuring the intensity of various X-rays as a function of position within the probe beam as reflected with the positions of the X-rays within said reflected probe beam corresponding to specific angles of incidence with respect

to said surface; and separately measuring the tilt of said sample in order to either adjust said tilt or to correct the X-ray measurements to account for said tilt, said tilt measuring comprising the steps of:

generating a beam of light;

focusing said beam of light on the surface of said sample;

measuring the reflected beam of light with a position sensitive detector; and

determining changes in the tilt of said sample based on the measurements made by the position sensitive detector.

31. A method as recited in claim 29 or 30 further wherein said incident beam of light is focused in a manner such that it includes at least one ray that is substantially normal to said surface of said sample.

32. A method as recited in claim 29 or 30 wherein said step of generating a beam of light includes using a laser light source.

33. A method as recited in claim 29 or 30 wherein said position sensitive detector is a photodiode detector.

34. A method for measuring the tilt of a sample for use in an X-ray reflectometry system comprising the steps of:

generating a beam of light;

passing said beam of light through a beam splitter;

using a lens to focus said beam of light on the surface of said sample;

returning at least a portion of the reflected beam back through said lens to said beam splitter and reflecting it to a position sensitive detector;

using said position sensitive detector to measure the beam of light; and

determining changes in the tilt of said sample based upon the measurements of the position sensitive detector.

35. A method as recited in claim 34 further wherein said incident beam of light is focused in a manner such that it includes at least one ray that is substantially normal to said surface of said sample.

36. A method as recited in claim 34 wherein said step of generating a beam of light includes using a laser light source.

37. A method as recited in claim 34 wherein said position sensitive detector is a photodiode detector.

38. A method as recited in claim 29 or 34 wherein said tilt is adjusted based on said tilt measurements.

39. A method as recited in claim 29 or 34 wherein said X-ray measurements are corrected based on said tilt measurements.

40. A method of measuring the characteristics of a thin film layer on the surface of a sample comprising the steps of:

generating a probe beam of X-rays;

focusing said probe beam on the surface of said sample such that various X-rays within the focused probe beam create a range of angles of incidence with respect to said surface;

measuring the intensity of various X-rays as a function of position within the probe beam as reflected with the positions of the X-rays within said reflected probe beam corresponding to specific angles of incidence with respect to said surface; and

separately measuring the vertical position of said sample in order to either adjust said vertical position relative to the focus of said focused

probe beam or to correct the X-ray measurements to account for the relative vertical position.

41. A method as recited in claim 40 wherein said relative vertical position of said sample is adjusted.

42. A method for measuring changes in the vertical position of a sample for use in an X-ray reflectometry system comprising the steps of:

generating a beam of light;

passing said beam through a beam splitter;

using a lens to focus said beam of light on the surface of said sample;

returning at least a portion of the reflected beam back through said lens to said beam splitter and reflecting it from said beam splitter;

using a second lens to bring the beam reflected from said beam splitter to a focus near a chopper;

measuring the movement of the shadow cast by said chopper using a position sensitive detector; and

determining changes in the vertical position of said sample based upon the measurements of said shadow.

43. A method of measuring the characteristics of a thin film layer on the surface of a sample including the steps of generating a probe beam of X-rays; focusing said probe beam on the surface of said sample such that various X-rays within the focused probe beam create a range of angles of incidence with respect to said surface; measuring the intensity of various X-rays as a function of position within the probe beam as reflected with the positions of the X-rays within said reflected probe beam corresponding to specific angles of incidence with respect to said surface; and separately measuring the vertical position of said sample in order to either adjust said vertical position relative to the focus of said focused probe beam or to correct the X-ray measurements to

account for the relative vertical position, said vertical position measuring comprising the steps of:

generating a beam of light;

passing said beam through a beam splitter;

using a lens to focus said beam of light on the surface of said sample;

returning at least a portion of the reflected beam back through said lens to said beam splitter and reflecting it from said beam splitter;

using a second lens to bring the beam reflected from said beam splitter to a focus near a chopper;

measuring the movement of the shadow cast by said chopper using a position sensitive detector; and

determining changes in the vertical position of said sample based upon the measurements of said shadow.

44. A method as recited in claim 42 or 43 further wherein said beam of light is focused in a manner such that it includes at least one ray that is substantially normal to said surface of said sample.

45. A method as recited in claim 42 or 43 wherein said step of generating a beam of light includes using a laser light source.

46. A method as recited in claim 42 or 43 wherein said position sensitive detector is a photodiode detector.

47. An apparatus for measuring the characteristics of a thin film layer on the surface of a sample comprising:

means for generating a probe beam of X-rays;

means for focusing said probe beam on the surface of said sample such that various X-rays within the focused probe beam create a range of angles of incidence with respect to said surface;

means for measuring the intensity of various X-rays as a function of position within the probe beam as reflected with the positions of the X-rays within said reflected probe beam corresponding to specific angles of incidence with respect to said surface; and

means for separately measuring the tilt of said sample in order to either adjust said tilt or to correct the X-ray measurements to account for said tilt.

48. An apparatus for measuring the characteristics of a thin film layer on the surface of a sample comprising:

means for generating a probe beam of X-rays;

means for focusing said probe beam on the surface of said sample such that various X-rays within the focused probe beam create a range of angles of incidence with respect to said surface;

means for measuring the intensity of various X-rays as a function of position within the probe beam as reflected with the positions of the X-rays within said reflected probe beam corresponding to specific angles of incidence with respect to said surface; and

means for separately measuring the vertical position of said sample in order to either adjust said vertical position relative to the focus of said focused probe beam or to correct the X-ray measurements to account for the relative vertical position.

49. An X-ray reflectometer for evaluating characteristics about a sample comprising:

an X-ray source for generating a first probe beam of X-rays directed to reflect off of the sample;

a first detector for measuring the intensity of the reflected first probe beam and generating first output signals in response thereto;

a processor for evaluating the sample based on the first output signals;

a light source for generating a second probe directed to reflect off the sample; and

a second detector for monitoring the second probe beam after it reflects of the sample and generating second output signals in response thereto, said second output signals being indicative of the orientation or vertical position of the sample and wherein said processor utilizes the second output signals to improve the evaluation of the sample.

50. A reflectometer as recited in claim 49 wherein said processor utilizes the second output signals to change the orientation of the sample.

51. A reflectometer as recited in claim 49 wherein said processor utilizes the second output signals in an algorithm to correct for measurement errors induced by variations in the orientation of the sample.

52. A reflectometer as recited in claim 49 wherein said second detector measures changes in the angular direction of the reflected second probe beam in order to provide information about the tilt of the sample

53. A reflectometer as recited in claim 49 wherein said second detector is a position sensitive detector.

54. A reflectometer as recited in claim 49 wherein said processor utilizes the second output signals to change the tilt of the sample.

55. A reflectometer as recited in claim 49 wherein said second detector is configured to determine the vertical position of the sample.

56. A reflectometer as recited in claim 49 further including a focusing element for focusing the first probe beam on the surface of the sample and wherein the second output signals are used by the processor to control the vertical height of the sample to keep the first probe beam in focus on the sample surface.

57. An X-ray reflectometer for evaluating characteristics about a sample comprising:

an X-ray source for generating a first probe beam of X-rays directed to reflect off of the sample;

a first detector for measuring the intensity of the reflected first probe beam and generating first output signals in response thereto;

a processor for evaluating the sample based on the first output signals;

a light source for generating a second probe directed to reflect off the sample; and

a second detector for monitoring the second probe beam after it reflects of the sample and generating second output signals in response thereto, said second output signals being indicative of the orientation of the sample with respect to the first probe beam and the first detector and wherein said processor utilizes the second output to measure the orientation of the sample.

58. A method for measuring changes in the vertical position of a sample for use in an X-ray reflectometry system comprising the steps of:

generating a beam of light;

using a lens to focus said beam of light on the surface of said sample;

directing at least a portion of the reflected beam to a second lens;

using said second lens to bring the reflected beam to a focus near a chopper;

measuring the movement of the shadow cast by said chopper using a position sensitive detector; and

determining changes in the vertical position of said sample based upon the measurements of said shadow.

59. A method of measuring the characteristics of a thin film layer on the surface of a sample including the steps of generating a probe beam of X-rays; focusing said probe beam on the surface of said sample such that various X-rays within the focused probe beam create a range of angles of incidence with respect to said surface; measuring the intensity of various X-rays as a function of position within the probe beam as reflected with the positions of the X-rays within said reflected probe beam corresponding to specific angles of incidence with respect to said surface; and separately measuring the vertical position of said sample in order to either adjust said vertical position relative to the focus of said focused probe beam or to correct the X-ray measurements to account for the relative vertical position, said vertical position measuring comprising the steps of:

generating a beam of light;

using a lens to focus said beam of light on the surface of said sample;

directing at least a portion of the reflected beam to a second lens;

using said second lens to bring the reflected beam to a focus near a chopper;

measuring the movement of the shadow cast by said chopper using a position sensitive detector; and

determining changes in the vertical position of said sample based upon the measurements of said shadow.

60. A method as recited in claim 58 or 59 further wherein said beam of light is focused in a manner such that it includes at least one ray that is substantially normal to said surface of said sample.

61. A method as recited in claim 58 or 59 wherein said step of generating a beam of light includes using a laser light source.

62. A method as recited in claim 58 or 59 wherein said position sensitive detector is a photodiode detector.